

Larvae of *Epipleoneura manauensis* Santos and *Roppaneura beckeri* Santos with a key to the genera of known Neotropical Protoneuridae larvae (Odonata: Zygoptera)

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The larva of *Epipleoneura manauensis* is described and illustrated based on last-stadium larvae and exuviae of reared larvae collected in a black-water stream in Manaus, Amazonas State, Brazil. The larva of *Roppaneura beckeri* is described and illustrated based on exuviae of reared larvae collected from the water accumulated in the axils (phytotelmata) of *Eryngium floribundum* (Umbelliferae), in Florestal, Minas Gerais State, Brazil. The larva of *E. manauensis* can be distinguished from that of *E. metallica*, the only other species in the genus *Epipleoneura* with described larvae, by the presence of four palpal setae (three in *E. metallica*) and by the transverse dark band on the distal third of the gills (color pattern absent in *E. metallica*). The larva of *R. beckeri* can be distinguished from all other described Neotropical Protoneuridae larvae by the presence of eight to nine palpal setae. An illustrated key to the genera of known Neotropical Protoneuridae larvae is provided.

A larva de *Epipleoneura manauensis* é descrita e ilustrada a partir de larvas e exúvias de larvas de último estádio; estas foram coletadas em igarapés em Manaus, Amazonas, Brasil e criadas em condições de laboratório. A larva de *Roppaneura beckeri* é descrita e ilustrada a partir de exúvias de larvas coletadas em fitotelmata de *Eryngium floribundum* (Umbelliferae) e criadas em condições de laboratório, em Florestal, Minas Gerais, Brasil. A larva de *E. manauensis* pode ser diferenciada da larva de *E. metallica*, a única espécie no gênero que possui a larva descrita, pela presença de quatro cerdas palpais (três cerdas presentes em *E. metallica*) e pela faixa transversal de pigmentação mais escura no terço distal do comprimento da brânquia (padrão de coloração ausente em *E. metallica*). A larva de *R. beckeri* pode ser diferenciada de todas as larvas conhecidas de protoneurídeos Neotropicais pela presença de oito a nove cerdas palpais. Uma chave ilustrada para identificar os gêneros com larvas conhecidas de Protoneuridae Neotropical é fornecida.

Keywords: aquatic insects; Amazonia; damselfly; *Eryngium*; phytotelmata; taxonomy

Introduction

The Neotropical Protoneuridae includes 113 species in 16 genera (Garrison et al., 2010). The species in this family are distributed from southern North America to Argentina. The adults have a thin body, very slender abdomen and delicate flight. The immature stages of the family are

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poorly known, as only six genera and 15 species have formally described larvae, representing less than 1/8 of the known species. The genera with described larvae are: *Epipleoneura* Williamson, 1915; *Idioneura* Selys, 1860; *Microneura* Selys, 1886; *Neoneura* Selys, 1860; *Peristicta* Hagen in Selys, 1860; *Protoneura* Selys in Sagra, 1857 (Anjos-Santos et al., 2011; De Marmels, 2007; Geijskes, 1954; Meurgey, 2008, 2010; Needham, 1939; Novelo-Gutiérrez, 1994; Pessacq, 2007; Santos, 1969, 1972; Souza et al., submitted; Westfall, 1964). The larva of *Forcepsioneura sancta* (Hagen in Selys, 1860) is currently being described (Pessacq, pers. comm.).

In South America, *Epipleoneura* has 25 species (Garrison et al., 2010), but only the larva of *E. metallica* Rácenis, 1955, has been described (De Marmels, 2007). *Roppaneura* Santos, 1966 is a monotypic genus represented by *R. beckeri* Santos, 1966, whose larvae breed in the phytotelmata of Umbelliferae in Minas Gerais State, Brazil. Machado (1976, 1981) studied the breeding-sites of larvae of *R. beckeri* but the larval description was not published.

The aim of this study is to describe the larva of *E. manauensis* Santos, 1964, and *R. beckeri*, and to present an illustrated key to the genera of known Neotropical Protoneuridae larvae. Additional comments about the genera with described larvae are provided.

Material and methods

The larval descriptions were based on last-stadium larvae and exuviae of reared larvae, allowing species identification.

Larvae of *E. manauensis* were collected in the Reserva Florestal Ducke, Manaus, Amazonas State, Brazil. The larvae (6♀ and 7♂) were collected in a black-water stream in Amazon lowland forest, with acidic water (pH range: 3.7–5), width varying from 2 to 3 m and depth from 0.3 to more than 0.6 m. Larvae were collected among aquatic plants (*Tonina fluvialis* Aubl., Eriocaulaceae) at stream margins with moderate flow, in open area with high incidence of sunlight inside the forest.

Larvae of *R. beckeri* were sampled in phytotelmata formed by the base of the leaves of *Eryngium floribundum* Cham. & Schlecht. (Umbelliferae) in Florestal, Minas Gerais, Brazil.

The mandibular formula is according to Watson (1956). Abbreviations: S1–S10: abdominal segments 1 to 10; F-0: last-stadium larva. Photographs were taken using a Leica M165 with Automontage software 3.5 and a Nikon D90. Drawings in the key were adapted from the original descriptions mentioned in the introduction and are not to scale. The examined specimens are deposited in the Coleção de Invertebrados do Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Amazonas, Brazil and the Angelo B.M. Machado personal collection, Belo Horizonte, Brazil (ABMM).

Description of larvae

Epipleoneura manauensis Santos, 1964

(Figures 1, 2a–k)

Larva. 16.5 mm in length including gills; light brown in color; femora and tibiae with transverse, dark brown bands (Figure 1).

Head. Subpentagonal in shape (Figure 2a), almost two times as wide as long, with posterior margin concave; occipital lobes rounded, obtuse, not produced laterally, with short spines on the posterior margin. Anterior margin of labrum with two or three rows of setae along its length.



Figure 1. *Epipleoneura manauensis* Santos, 1964 (Odonata, Protoneuridae), larva, dorsal view. (Photo: Fernando da Costa).

Antenna 7-segmented, longer than head; third antennomere the longest with dark, transverse, band at basal third; fourth antennomere with dark, transverse band on the basal 2/3; 5th and 6th antennomeres with dark, transverse band on the basal half (Figures 1, 2a). Lengths (mm) of antennomeres: 0.1, 0.22, 0.37, 0.28, 0.14, 0.1, 0.05. Prementum–postmentum articulation surpassing first coxa. Prementum pentagonal, long, width 0.5–0.53 times its length, concave, lateral margins slightly constricted at basal half and with a dark spot on each side at the lateral margin (Figure 2b), apical half of lateral borders beset with approximately 10–12 spines, the distal spine located more dorsally and vertically, under insertion of the palp (Figure 2b, c); one pair of premental setae, anterior margin strongly convex and crenulated, almost triangular, crenulations short and blunt. Labial palp with four long setae, lateral border without spines, with only small crenulations (Figure 2c, d); apical portion of labial palp between end hook and movable hook obtuse, with about 6–8 short, blunt denticles, with a small incision between end hook and obtuse median portion; end hook small, curved; movable hook short and sharp, about 2/3 the length of external border of the palp. Mandibular formula: L 1+2345 0 ab, R 1'1234 y a (Figure 2e).

Thorax. Prothorax small, quadrangular, with distal region of lateral margin rounded and posterior margin almost straight (Figures 1, 2a). Wing pads reaching distal margin of S4 or S5. Legs light brown, femora with two distinct dark, transverse bands, basal and apical regions dark; tibiae with one transverse band on the basal third, less definite in the hind tibia (Figure 2f); femora and tibiae with some spine-like setae on ventral and dorsal margins; tibiae with two distinct spines on dorsal surface, on the distal half; apical ventral region of tibiae with a group of very short, simple spines; tarsus 3-jointed, with two rows of ventral setae, tarsal claws simple and sharp.

Abdomen. Short, cylindrical, light brown, with one dorsolateral dark spot on each side of S1–5 (Figure 1); row of short spines on posterior margin of following segments: S5, some lateral spines only; S6, dorsally; S7, dorsally, surpassing lateral border to ventral portion; S8–10, entire length (interrupted at region of gonapophyses on S8–9) (Figure 2g, h). Male gonapophyses conical and sharp, surpassing distal end of S9 (Figure 2i). Female gonapophyses surpassing distal end of S10; external lobes (outer valves) ending in a sharp projection and with three thick spines ventrally (Figure 2g, h). Caudal gills elongate and rigid, about six times as long as wide (as long as S3–S10 together), nodus not evident; dorsal and ventral margins almost parallel, apex rounded, with a complete row of thick spines along entire dorsal and ventral borders; median gill with 23–27 spines on dorsal margin, 15–20 spines on ventral margin; lateral gills with 17–20 spines on dorsal

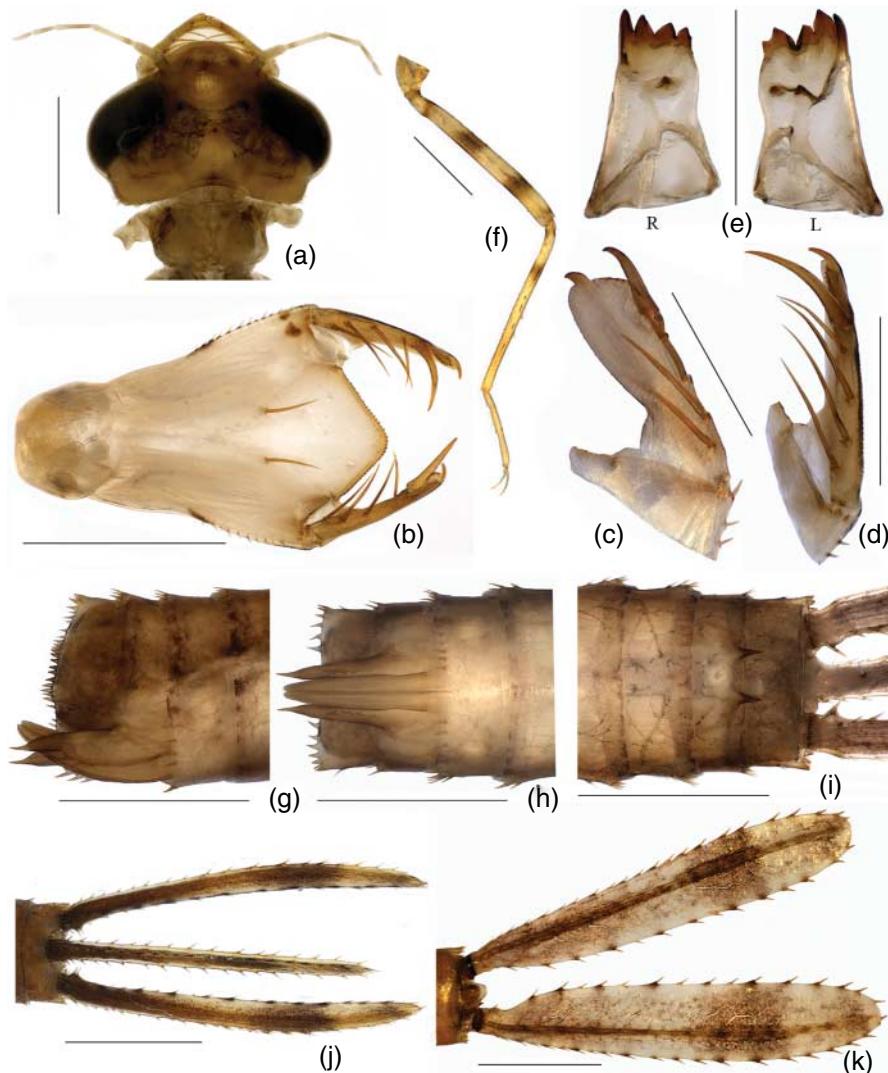


Figure 2. Last stadium larva of *Epipleoneura manauensis* Santos, 1964 (Odonata, Protoneuridae): (a) head, dorsal view; (b) prementum, dorsal view; (c) and (d) labial palps; (e) right (R) and left (L) mandibles, inner side; (f) posterior leg, lateral view; (g) female gonapophyses, lateral view; (h) female gonapophyses, ventral view; (i) male gonapophyses, ventral view; (j) median and lateral gills, dorsal view; (k) median and lateral gills, left lateral view (exuvia). (Scale bars: (a), (b), (f)-(k) 1 mm; (c)-(e): 0.5 mm).

margin, 23–28 spines on ventral margin; lateral keel well developed, reaching apex of gill, with 18–24 spines on lateral gills and 17–20 spines on median gill; alternated pigmentation, light and brown areas, forming a distinct transverse band on the distal third (Figure 2j, k); petiole of median gill with two divergent spines ventrally, petiole of lateral gills with three aligned spines on inner side. Female cercus with apex pointed; male cercus small with apex rounded.

Measurements (mm; females $n = 6$, males $n = 7$). Total length (without gills), female: 13.5, males: 13.5–16.5; head length, female: 1.58, male: 1.4; head width, female: 2.8, male: 2.7–2.8; antenna, female: 3.6, male: 3.2–3.5; prementum length, female: 3.1, male: 2.7–2.8; prementum max. width, female: 1.6, male: 1.5; hind wing pads, female: 3.6, male: 3.5–3.6; forewing pads,

female: 3.75, male: 3.8–3.9; femur, female: F1: 1.9, F2: 2.5, F3: 3.2, male: F1: 1.7–1.9, F2: 2.2–2.5, F3: 2.8–2.9; tibia, female: T1: 2.1, T2: 2.5, T3: 3.1, male: T1: 1.8–2, T2: 2.1–2.3, T3: 2.6–2.9; cercus, female: 0.4, male: 0.6; median gill, female: 3.1, male: 2.6–2.8; lateral caudal lamellae, female: 3.4, male: 3.2–3.4.

Material examined. Brazil: Amazonas State: Manaus: Reserva Florestal Ducke, highway AM 010 – Km 26 (02°55'47" S; 59°58'22" W): Igarapé (stream) Barro Branco, on aquatic plant *Tonina fluvialis* (Eriocaulaceae): 1♀ exuvia (F-0, reared in laboratory), 28 November 2009, emerged on 1 December 2009, 1♂ exuvia (F-0, reared in laboratory), 28 November 2009, emerged on 5 December 2009, 5♂ and 2♀ (F-0), 28 November 2009, 1♂ exuvia (F-0, reared in laboratory), 17 March 2010, emerged on 30 March 2010, 1♀ exuvia (F-0, reared in laboratory), 17 March 2010, emerged on 26 March 2010, 2♀ exuviae (F-0, reared in laboratory), 21 May 2011, emerged on 22–28 May 2011, all Neiss, U.G. leg.

Larval diagnosis for the genus *Epipleoneura*

(1) Antenna 7-segmented; (2) one pair of mental setae; (3) labial palp with three or four long setae; (4) apical margin of labial palp between end hook and movable hook obtuse, without teeth, only bluntly denticulated; (5) caudal gills elongate, rigid, about six times as long as wide, not divided between basal and apical portions and with thick spines over entire length; apex rounded.

***Roppaneura beckeri* Santos, 1966**

(Figures 3, 4a–j)

Larva. Small, about 13 mm in length with gills, abdomen dark, unpatterned, femur and tibia with dark brown transverse bands (Figure 3).

Head. Very unusual, transverse, with compound eyes strongly pronounced laterally and anteriorly, more than two times as wide as long, with the concavity of the occipital margin wide and shallow, almost aligned with the postocular lobe (Figure 4a); occipital lobes rounded, obtuse, not produced laterally, with short spines on posterior margin. Labrum covered with thin setae, increasing in length to anterior margin. Antenna 7-segmented, shorter than head; third antennomere the longest, first and second antennomeres strong, twice as wide as the other antennomeres



Figure 3. *Roppaneura beckeri* Santos, 1966 (Odonata, Protoneuridae): exuvia, dorsal view (Scale bar: 2 mm).

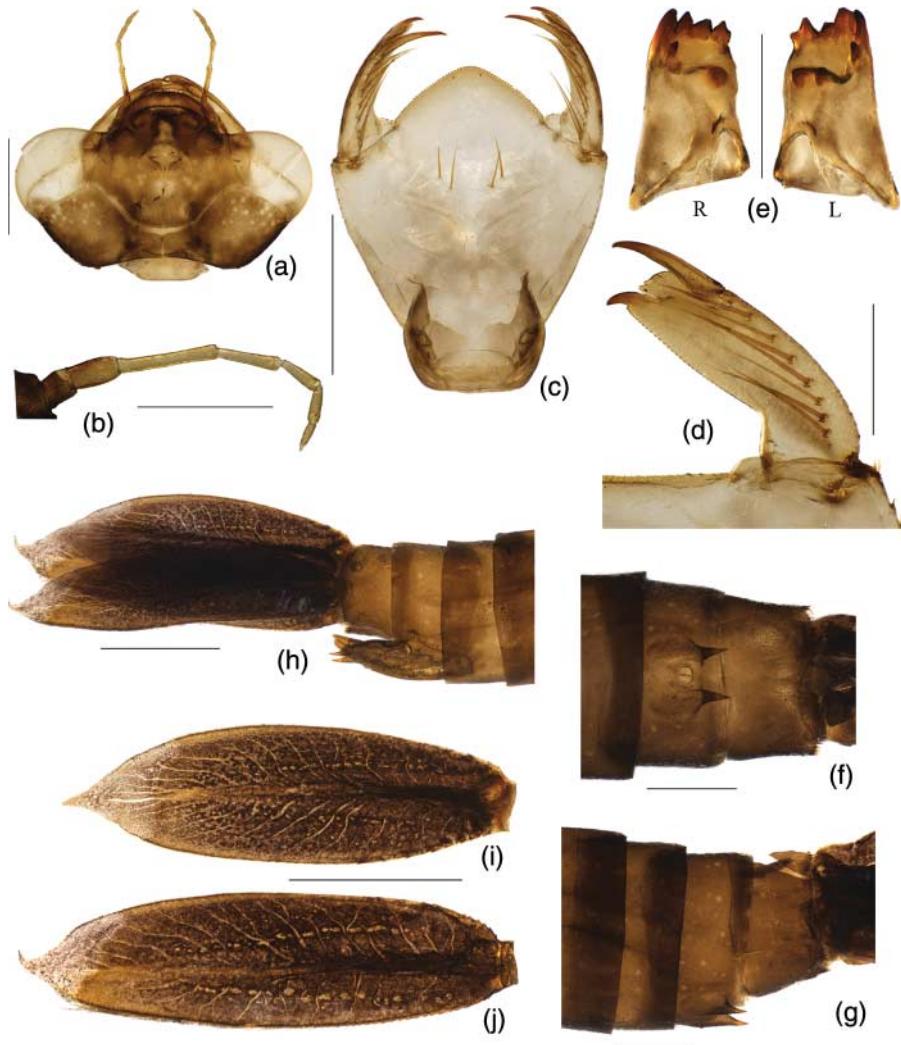


Figure 4. Exuvia of *Roppaneura beckeri* Santos, 1966 (Odonata, Protoneuridae): (a) head, dorsal view; (b) left antenna; (c) prementum, dorsal view; (d) right labial palp; (e) right (R) and left (L) mandibles, inner side; (f) male gonapophyses, ventral view; (g) male gonapophyses, lateral view; (h) female, last abdominal segments with complete gills, right lateral view; (i) median gill, right lateral view; (j) lateral gill, right lateral view. (Scale bars: (b), (d)–(g): 0.5 mm; (a), (c), (h)–(j): 1 mm).

(Figure 4a, b), presence of some vertically oriented setae situated on apical portion of the three distal antennomeres. Lengths (mm) of antennomeres: 0.12, 0.18, 0.37, 0.26, 0.15, 0.12, 0.1. Prementum–postmentum articulation reaching posterior margin of first coxa. Prementum short, almost as long as wide (width 0.85 times its length); slightly concave; with two pairs of premental setae (Figure 4c) (one exuvia has three pairs of setae, and three others have three setae on at least one side of the prementum); anterior margin strongly convex, rounded and finely crenulated; crenulations separated by short setae; with a pair of small, blunt tubercles on dorsal margin (Figure 4c); apical half of lateral borders covered with 8–12 small spines; a group of two spines plus two or three short setae located more dorsally and vertically under the insertion of the labial palp, except for the most distal one, which is always small (Figure 4d). Labial palp with eight setae, sometimes nine, longer than width, without spines externally on lateral border, only small

crenulations (Figure 4d); apical margin of labial palp between end hook and movable hook obtuse, almost quadrate, with approximately 6–7 short, blunt denticles, with a strong incision between end hook and the obtuse median portion; end hook and movable hook short. Mandibular formula: L 1+2345 y ab, R 1·1234 y a (Figure 4e).

Thorax. Prothorax small, quadrangular, without lateral projections, wing pads reaching distal margin of S3. All legs light brown, femur with one distinct dark, transverse band on the distal third; tibiae with one dark, transverse band at midlength (Figure 3); femur with short spines on the anterior margin, tibiae with spine-like setae increasing in size to tip, apical ventral region of tibiae with trifid spine-like setae; tarsus 3-jointed, third tarsomere as long as first and second together, ventral side of first tarsomere entirely covered with setae, ventral side of second and third tarsomeres with two rows of setae; tarsal claws simple and short, robust, enlarged in the basal half and sharp.

Abdomen. Dark, short, cylindrical, with a strong incision on the posterior dorsal margin of S10 (Figure 3); posterior margin of S10 with row of short spines. Male gonapophyses thick, conical and sharp, surpassing distal end of S9 (Figure 4f, g). Female gonapophyses surpassing distal end of S10; external lobes (outer valves) without spines, only thin setae ventrally, ending in a sharp projection (Figure 4h). Caudal gills foliate, not rigid, about 3.5 times as long as wide (as long as S6–S10 together), with ventral and dorsal margins almost parallel and tracheation well evident, nodus not evident; with apical portion colorless, apex pointed, lateral gills with thinner apex than the median gill (Figure 4i, j); dorsal and ventral carina with spine-like setae along their length, decreasing in size to the apex, being replaced by long hair-like setae near the colorless portion; petiole of gills with group of short spines on both inner and outer lateral margins. Female cercus short, almost conical, with apex blunt, male cercus small with apex rounded.

Measurements (mm; females $n = 5$, males $n = 5$). Total length (without gills), female: 10.5–10.8, males: 10.5–10.7; head length, female: 1.5–1.7, male: 1.4–1.6; head width, female: 2.9–3.1, male: 3; antenna, female: 1.3, male: 1.25; prementum length, female: 2, male: 1.9–2; prementum max. width, female: 1.7–1.8, male: 1.6–1.7; wing pads, female: 3, male: 3; femur, female: F1: 1.6, F2: 2, F3: 2.3–2.5, male: F1: 1.5–1.6, F2: 1.8–2, F3: 2.3–2.4; tibia, female: T1: 1.8, T2: 1.9–2.1, T3: 2.2–2.4, male: T1: 1.4–1.7, T2: 1.7–1.9, T3: 2–2.2; abdomen length, female: 6.2–6.7, male: 6.2–6.8; abdomen max. width, female: 1.6–1.9, male: 1.6–1.8; median gill length, female: 2.6–2.8, male: 2.5–2.7; lateral gill length, female: 2.8–3.1, male: 2.8–3.1; gills width, female and male: 0.8.

Material examined. Brazil: Minas Gerais State: Florestal: (19°53'11.84" S; 44°25'55.68" W): all larvae were collected in water-holding axils (phytotelmata) of *Eryngium floribundum* Cham. & Schlecht. (Umbelliferae) and reared in the laboratory until adult emergence: 1♂ exuvia (F-0, adult emerged on 4 April 1970), 1♂ and 1♀ exuviae (F-0, adults emerged on 2 and 17 August 1976), 1♀ exuvia (F-0, adult emerged on 4 May 1976), 2♂ and 1♀ exuviae (F-0, adults emerged on 10 June 1976 and 2 June 1976), 2♂ exuviae (F-0, adults emerged on 17 and 22 August 1977), all Machado, A.B.M. leg.

Larval diagnosis for the genus *Roppaneura*

(1) Head transverse with compound eyes strongly pronounced laterally; (2) concavity of the occipital margin wide and shallow, almost aligned with the postocular lobe; (3) antenna 7-segmented; (4) two pairs of premental setae (sometimes three); (5) labial palp with eight or nine setae; (6)

one pair of small tubercles on distal margin of prementum; (7) caudal gills foliated, flexible, not divided between basal and apical regions and with apex colorless and pointed.

Additional comments on the known larvae of Neotropical Protoneuridae

Epipleoneura Williamson, 1915 occurs only in South America and is represented by 25 species. In Brazil, this genus is represented by 15 species (Garrison et al., 2010; Lencioni, 2005). This genus belongs to the group of larvae with gills that lack a definite nodus (i.e., not divided into a thick basal half and a leaf-like apical portion) (Figure 2j, k). The larva of *E. manauensis* can be distinguished from that of *E. metallica*, which is the only other species in the genus with a described larva, by the presence of four palpal setae (three in *E. metallica*) and by the transverse dark stripe on the distal third of the gill (absent in *E. metallica*). Moreover, *E. manauensis* seems to have a much smaller number of spines on the margins of the gills as compared to *E. metallica* (De Marmels, 2007).

Adults of this genus are common in primary forest in the Amazon region, although sometimes they are difficult to see in the forest due to their general dark coloration, delicate flight and their behavior of perching on the leaf tips or branches of riparian vegetation in shaded areas. In contrast, the larvae are not abundant in the sampled sites, and they were associated mainly with submerged root mats, located at the edges of streams in the stretches with moderate flow.

Forcepsioneura Lencioni, 1999 is represented by six species and is restricted in distribution to Atlantic Forest in the south and southeast regions of Brazil (Garrison et al., 2010; Lencioni, 2005). The larva of *F. sancta* is currently being described by P. Pessacq (pers. comm.) and was included in the key below from information shared among the authors. The genus belongs to the group of larvae with undivided gills and can be distinguished from the other genera using the key below.

Idioneura Selys, 1860 is represented by only two species (restricted to the Atlantic Forest in SE Brazil) (Lencioni, 2009). Only the larva of *I. ancilla* Selys, 1860 is known (Santos, 1969), from specimens collected at the edge of a pond bordered by forest, with large amounts of detritus, especially leaves. This genus belongs to the group of larvae with gills lacking a definite nodus. However, like *Epipleoneura*, it has a prominent lateral keel (Figure 6f). The larvae of this genus can be distinguished from those in the other genera by the shape of the gills (Figure 6f) and by the presence of three pairs of premental setae (Figure 5b) (a feature sometimes found only in *Roppaneura*); moreover, the larva has five palpal setae (Santos, 1969).

Microneura Selys, 1886 is a monotypic genus (*M. caligata* Hagen in Selys, 1886) restricted to Cuba (Westfall, 1964; Westfall & May, 2006). The larva belongs to the group with gills having a definite nodus, with a thick (rigid) basal half and a leaf-like apical portion (Figure 6c). It has 7-segmented antennae, one pair of premental setae and three to four palpal setae, which are characteristics shared with *Protoneura* and *Neoneura*. The larvae of these latter genera can be distinguished from that of *Microneura* by the characters presented in the key plus the difference in the number of spines on the ventral and dorsal margins of the thick basal half of the gills. *Microneura* larvae have approximately 20 spine-like setae on the dorsal margin and about 30 on the ventral margin of the lateral gill, and about 25 spine-like setae on the dorsal margin and 30 spine-like setae on the ventral margin of the median gill. *Neoneura* has less than 15 spine-like setae on the dorsal margin of the lateral gill, and less than 20 spine-like setae on the ventral and dorsal margins of the median gill. Another interesting character illustrated by Westfall (1964) is the shape of the anterior margin of the prementum of *Microneura*, which is very convex and rounded, almost semi-oval. In *Neoneura*, the anterior margin of the prementum is also highly convex, but not rounded like that of *Microneura* (Anjos-Santos et al., 2011; De Marmels, 2007; Geijskes, 1954; Needham, 1939; Westfall, 1964). The larvae are found in rocky streams in the Trinidad Mountains of Cuba where they hang on the underside of rocks (Westfall, 1964).

As mentioned by De Marmels (2007) and as found in the present study, the distribution of the marginal spines on the gills seems to be an important character for the diagnosis at the generic level for some larvae of Protoneuridae.

Neoneura Selys, 1860 is a large genus with 29 species occurring from southern USA to Uruguay, with only seven described larvae: *N. aaroni* Calvert, 1903; *N. carnatica* Selys, 1886; *N. ethela* Williamson, 1917; *N. fulvicollis* Selys, 1886; *N. joana* Williamson, 1917; *N. kiautai* Machado, 2007 and *N. maria* (Scudder, 1866) (Anjos-Santos et al., 2011; De Marmels, 2007; Geijskes, 1954; Needham, 1939; Souza et al., submitted; Westfall, 1964; Westfall & May, 2006). The larvae of the genus have 7-segmented antennae, two to five palpal setae (two or four in *N. kiautai*; rarely five in *N. aaroni* and males of *N. joana*), and tibiae with one dark, transverse band, although this band is absent in some species. The gills of the known larvae are divided between basal and apical portions (Figure 6a), similar to those of *Microneura* and *Protoneura* larvae (Figures 6b, c). The known larvae of *Neoneura* species can be distinguished by the diagnostic characters presented in Anjos-Santos et al. (2011) and by the key to South American species available in Souza et al. (submitted).

In Brazil the genus is well represented, with 19 species recorded, some of which are considered endemic (*N. anaclara* Machado, 2005; *N. jurzitzai* Garrison, 1999; *N. kiautai* Machado, 2007; *N. leonardoi* Machado, 2005; *N. lucas* Machado, 2002; *N. moorei* Machado, 2003, and *N. schreiberi* Machado, 1975). Adults are normally seen flying rapidly close to the water surface of forest streams and rivers. Sometimes they can be seen perching on the tip of branches of riparian vegetation. Larvae are found in rapid streams under stones or associated with plant detritus in pool areas in streams and rivers (De Marmels, 2007; Geijskes, 1954; Westfall & May, 2006). Larvae of *N. ethela* were found in a river with thermal water, and this species appears to be able to stand high temperatures (35°C; Souza et al., submitted).

Peristicta Hagen in Selys, 1860 is represented by seven species; the genus is restricted to southern South America (Brazil, Paraguay, Uruguay and Argentina) and the male adults can be identified by the key presented in Pessacq and Costa (2007). The larvae of two species are described: *P. aeneoviridis* Calvert, 1909 and *P. forceps* Hagen in Selys, 1860 (Pessacq, 2007; Santos, 1972) and are characterized by the oblong (elliptical) shape of the gills. *Peristicta* belongs to the group whose gills are not divided between basal and apical portions (Figures 6e, 7b). The larvae have one pair of premental setae and five palpal setae (some individuals of *P. forceps* have four). Larvae are found in clear streams associated with the riparian vegetation (Santos, 1972; Pessacq, 2007).

Protoneura Selys in Sagra, 1857 adults are slender and dark with contrasting areas of red, orange, yellow, blue or green. This genus includes 21 species found from the southern USA and the Antilles to Bolivia (Garrison et al., 2010), with only four larvae described: *P. ailsa* Donnelly, 1961; *P. aurantiaca* Selys, 1886; *P. cupida* Calvert, 1903; *P. romanae* Meurgey, 2006 (Meurgey, 2008, 2010; Novelo-Gutiérrez, 1994). The larva of *P. capillaris* is included in the key by Westfall and May (2006), but it was not formally described. In Brazil, there are only four species registered (Lencioni, 2005); adults of *Protoneura* are found infrequently in deep primary Amazon forest and, like other dark protoneurids, are difficult to see under covered canopy except for their bright thoracic color. The larvae of the genus have 7-segmented antennae, one pair of premental setae, five palpal setae (six in *P. romanae*), tibia with two or three dark, transverse bands, and gills that are always divided, with a leaf-like apical portion (Figure 6b) as in the larvae of *Microneura* and *Neoneura*. The larvae of *Protoneura* can be distinguished from those of *Microneura* and *Neoneura* by the presence of five palpal setae and by the presence of two or three dark, transverse bands on the tibia (see the key). Larvae are found in accumulated organic litter and branches from the forest in pools or slow-flowing portions in rivers and streams (Meurgey, 2010; Novelo-Gutiérrez, 1994).

Roppaneura Santos, 1966, as mentioned above, is a monotypic genus found in the southeast region of Brazil. The larva was discovered by A.B.M. Machado in 1976 in a study of the fauna

associated with phytotelmata of the umbellifer *E. floribundum*. This plant grows in large numbers in wet areas, and it is able to hold rain water in its axils (up to 150 ml). This water is inhabited mainly by larvae of culicids and chironomids (Diptera) and provides a favorable environment for the development of larvae of *R. beckeri*. According to Machado (1976, 1981), one to nine (mean = 5) larvae were found per plant and the larvae of *R. beckeri* were always present in all examined plants more than 50 cm in diameter.

Machado (1981) discussed the strategies used by the larvae of *R. beckeri* to maximize the use of food resources and to reduce cannibalism between populations of different sizes that coexist in the same plant. He reported that the main explanation for the occurrence of one larva per leaf is the territorial behavior shown by the larvae of larger size (9th to 13th stadium) – each territory being represented by the space occupied with water in one leaf of *Eryngium*. In this same study, the author reported an agonistic behavior between large larvae placed in the same leaf, resulting in the dislodgment of one of the larvae to another leaf. This phenomenon of expulsion, which represented territoriality, contributes to the allocation of resources and to the reduction of cannibalism.

The larva of *R. beckeri* is unique compared to other known larvae in the family Protoneuridae; it belongs to the group of larvae whose gills lack a definite nodus. It has eight or nine palpal setae and the occipital margin is slightly concave, with the concavity being wide and shallow, almost aligned with the postocular lobe; this last feature is present in adults and comprises the diagnostic character for the genus. The larva can be easily distinguished from all described neotropical protoneurid larvae by the characters mentioned above plus its unique breeding site. Moreover it has other characters that are probably related to the breeding site, such as a short body and short thick tarsal claws.

Interestingly, three genera of Coenagrionidae with bromeliad-inhabiting larvae also have many palpal setae like *Roppaneura*: *Bromeliagrion* De Marmels in De Marmels & Garrison, 2005 (11–13 setae), *Diceratobasis* Kennedy, 1920 (8–12 setae) and *Leptagrion* Selys, 1876 (13–16 setae) (Costa et al., 2009; De Marmels, 1985; Torreias et al., 2008; Westfall, 1976). They can be distinguished from the larvae of *Roppaneura* by the presence of a well-developed tooth (pointed or obtuse) between the movable hook and the end hook, on the apical portion of the labial palp (in *Roppaneura* there is an obtuse portion between the movable hook and the end hook, which is typical of Protoneuridae), and by the shape of the gills – strongly petiolated and enlarged in the apical half in other coenagrionids, whereas in *Roppaneura* they are poorly petiolated with dorsal and ventral margins almost parallel (Figure 4j). The presence of many palpal setae in these larvae would be a convergent morphology relative to breeding-site, since the cited genera do not seem to have the same origin (De Marmels, 1985).

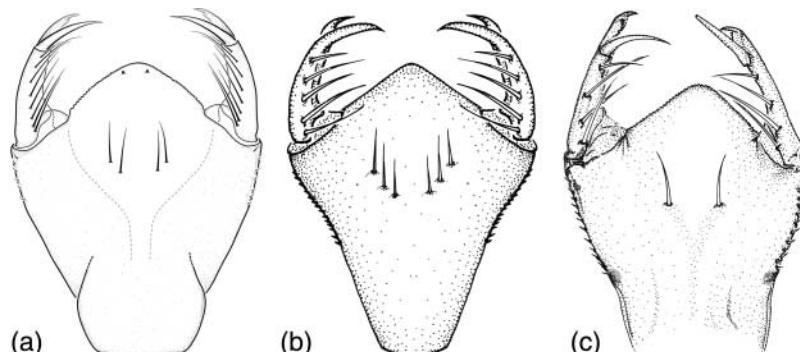


Figure 5. Prementa and labial palps (dorsal view) of: (a) *Roppaneura beckeri*; (b) *Idioneura ancilla*, adapted from Santos (1969); (c) *Epipleoneura manauensis*.

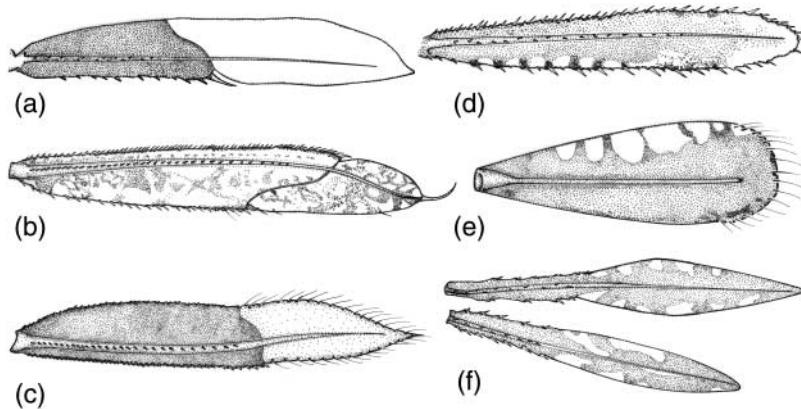


Figure 6. Gills (lateral view) of: (a) *Neoneura fulvicollis*, adapted from De Marmels (2007); (b) *Protoneura aurantiaca*, adapted from Novelo-Gutierrez (1994); (c) *Microneura caligata*, adapted from Westfall (1964); (d) *Epipleoneura metallica*, adapted from De Marmels (2007); (e) *Peristicta forceps*, adapted from Pessacq (2007); (f) *Idioneura ancilla*, adapted from Santos (1969).

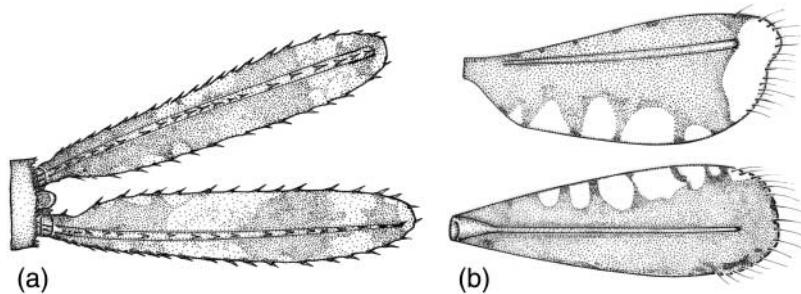


Figure 7. Gills (lateral view) of: (a) *Epipleoneura manauensis*; (b) *Peristicta forceps*, adapted from Pessacq (2007).

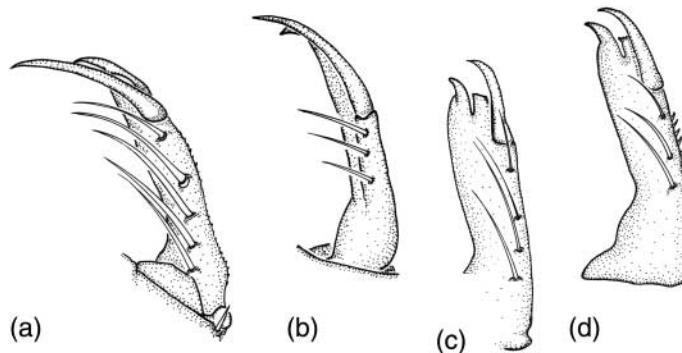


Figure 8. Right labial palp (dorsal view) of: (a) *Protoneura aurantiaca*, adapted from Novelo-Gutierrez (1994); (b) *Microneura caligata*, adapted from Westfall (1964); (c) *Neoneura joana*, adapted from Geijskes (1954); (d) *Neoneura kiautai*, adapted from Anjos-Santos et al. (2011).

Key to the genera of known Neotropical Protoneuridae larvae

1. Labial palp with eight or nine setae (larva lives in axils of Umbelliferae, Brazil) (Figure 5a)..... *Roppaneura*

1'. Labial palp with three to six setae (Figures 5b, c)..... 2

2. Prementum with three pairs of setae on dorsal surface (Figure 5b)..... *Idioneura*

2'. Prementum with one or two pairs of setae (Figure 5c)..... 3

3. Gills divided in two portions: a rigid sclerotized basal half and a membranous pale distal portion (Figures 6a–c)..... 6

3'. Gills not divided in two portions (Figures 6d–f, 7a,b)..... 4

4. Antenna 6-segmented; gills oblong (oval), about three times as long as wide with apex broad (Figure 7b)..... *Peristicta*

4'. Antenna 7-segmented; gills elongate, more than three times as long as wide with apex not broad (Figure 7a)..... 5

5. Labial palp with five or six setae (southeast region of Brazil)..... *Forcepsioneura*

5'. Labial palp with three or four setae (Figure 5c)..... *Epipleoneura*

6. Labial palp with five setae (except *P. romanae*, with six) (Figure 8a); tibiae with two or three dark, transverse bands; total length (excluding gills) less than 10 mm..... *Protoneura*

6'. Labial palp with three or four (rarely five) setae (Figures 8b–d); tibiae with only one or no dark, transverse band; total length (excluding gills) more than 12 mm..... 7

7. Nodus position of lateral gill at about 3/5 distal (Figure 6c); rigid portion of lateral gill with about 20 spine-like setae on dorsal margin and median gill with about 30 spine-like setae on ventral margin (only Cuba)..... *Microneura*

7'. Nodus position of lateral gills at about 1/2, 1/3 or 2/3; rigid portion of lateral gills with less than 15 spine-like setae on dorsal margin and median gill less than 20 spine-like setae on ventral margin (Figure 6a)..... *Neoneura*

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